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BALANCING TYCHE:
NONLINEARITY AND JOINT OPERATIONS

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ABSTRACT

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The purpose of this paper is to demonstrate that centuries of linear thought continues to shape U.S. war fighting doctrine, despite the fact that nonlinearity is more reflective of the actual nature of war. By recognizing and incorporating key aspects of nonlinear theory into a twenty-first century American approach to warfare, the U.S. military can overcome many of the theoretical limitations it currently faces in formulating Joint doctrine. The concept of nonlinearity involves the dynamic, interactive nature of warfare and the complex connectivity of the human dimension. It provides a construct for understanding the changing character of war and allowing for the recognition of friction before reaching culmination. Nearly a century ago, the Soviet Union embarked on a holistic investigation of warfare that propelled them to the forefront of innovative theory development, later manifest as doctrine, structure, education and procurement. If the U.S. military is to become truly Joint in application, then it must also subscribe to a common, sound doctrine. Nonlinearity offers a way to leverage the best of service cultures and capabilities, understand the dynamic nature of conflict and achieve both an adaptive and creative approach to decision making and war fighting.

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> "Preparing for the future will require new ways of thinking, and the development of forces and capabilities that can adapt quickly to new challenges and unexpected circumstances. The ability to adapt will be critical in a world defined by surprise and uncertainty."
>
> —Donald H. Rumsfeld[1]
> Secretary of Defense

The unforgettable events of 11 September, 2001 awoke, once again, a "sleeping giant". In response to terrorist attacks, recent and ongoing operations in Afghanistan have demonstrated effective innovation against a complex, distributed and adaptive enemy. But as the war on terror continues, the enemy will respond to coalition actions in unexpected ways. Unfortunately, the world of the terrorist will never be one of isolation. State sponsors will continue to finance, train and resource non-state actors as their surrogates in pursuance of national interests. As the United States and its allies confront these states, the complexion of nations and possibly entire regions may evolve in unforeseen directions. In anticipation of this prospect, long-term U.S. success will lie, as one analyst points out, in institutionalizing a culture that values adaptation so that tomorrow's creative solutions will not be the exception, but rather the rule.[2] The challenge facing the United States armed forces is to develop an effective military doctrine that meets the needs of government agencies and multi-national partners, as their holistic efforts are applied to deal with the emerging dimensions of terror. Such an effort represents a significant departure from the past and encompasses a fundamental change in the way the American military must think about war and its prosecution.

The purpose of this paper is to demonstrate that centuries of linear thought has and continues to shape war fighting doctrine, despite the fact that nonlinearity is more reflective of the actual nature of war. First described as "Tyche", the personification of fortune by Thucydides[3], more recently nonlinearity has become an increasingly important paradigm for understanding warfare, especially since the nineteenth century.[4] By recognizing and incorporating key aspects of nonlinear theory into a twenty-first century American approach to warfare, the U.S. military can overcome many of the theoretical limitations it currently faces in formulating Joint doctrine.

THE NATURE OF PARADIGMS

Since the dawn of time, man has sought to understand the world around him and his place within it. For Plato, man's cognitive world was always an approximation of a paradigm (a

clear and indisputable example, or standard against which to judge other instances).[5] But as Thomas Kuhn argued much later in his theory of scientific progress, scientific knowledge is more than purely objective; it rests upon "'dominant paradigms', accepted theories that reflect and uphold a certain viewpoint."[6] As an example, consider that Europe in the Middle-Ages functioned according to an elaborate system that linked natural phenomena to theology and government. It was an earth centered Ptolemaic taxonomy: precise, observable and wrong. Yet for centuries it defined European man's universe and his role within it.

Like many systems of the past, Aristotelian physics and cosmology reacted sensitively to seemingly minor inputs. Among these stimuli were the ideas offered by the scientist Galileo Galilie in his *Dialogue Concerning the Two Chief World Systems*.[7] Galileo observed inconsistencies in the Ptolemaic universe, ones that reinforced earlier observations by Johannes Kepler and Tycho Brahe. Through personal genius and advances in technology, Galileo documented nature through the use of a telescope. Thus, he further advanced the argument of a heliocentric universe. In short, by moving the sun to the center of the universe, he challenged over a thousand years of Catholic dogma and irrevocably changed the relationship between man, science, religion and nature.[8] As Kuhn would suggest, the Ptolemaic system was the dominant paradigm, but although it represented a generally accepted explanation of things, it suffered from observable anomalies. The strength of any paradigm rests in its ability to overcome anomalies; as scientists began to question the veracity of the Ptolemaic universe, the idea of a heliocentric universe gained favor.[9] Paradigms, however, do not give way easily, especially when societal structure, sources of power, institutions of learning and professional careers rest upon the propagation of their precepts: enter what Kuhn coined, "the paradigm shift". Once a dominant paradigm becomes so overloaded with exceptions, forced upon it by a growing number of observable anomalies, another replaces it. It is during the unstable transition period, when the old paradigm erodes against the onslaught of new thinking that *'revolutionary science*" appears.[10] Thus, the paradigm shift yields a new *Weltanschauung* and the ability to explore new possibilities with fresh thinking.[11]

In much the same way as Galileo sought to understand the universe, militaries have devoted a great deal of effort toward understanding their particular environment: war. This is especially true in the wake of the ultimate "paradigm shift", defeat. In such circumstances, having experienced first hand the fury of a new technology, tactic or operational art, defeated militaries typically conduct detailed analysis of change.[12] Carl von Clausewitz is perhaps the supreme example of this phenomenon. His was an intellectual journey, born of the Napoleonic throttling of Prussian forces at Jena-Auerstadt and culminating in a theory of war unique to the

literature of armed conflict.[13] By his example, through the study of history, generations of military officers sought to understand their profession; yet many only managed to take from it superficial analysis, dogma and false conclusions.[14] Why this occurred is due in great measure to the tools with which the legions of well intended professionals were equipped, namely their education, culture and the contemporary paradigm.[15] Today, U.S. officers are no less challenged.

LINEARITY

At an early age children learn, in geometry for example, that the shortest distance between two points is a straight line. Linear equations exhibit a character described by the conditions of *proportionality* and *additivity.* Proportionality means that changes in the system's input are proportional to its output. Additivity refers to the idea that the whole is equal to the sum of its parts.[16] Together these concepts suggest that if a line's equation is known, one can determine the exact value of each variable, as well as their proportion to each other. More importantly, one can therefore accurately predict the path of the line into the future. All of this assumes the equation is free of external influence and that its elements are precise and remain in isolation. From an analytical point of view, linearity also means that one can understand "the whole" by an examination of its parts. Much like the Ptolemaic Universe and Newtonian Physics, the linear paradigm proved, and in many ways continues to prove, valuable in both understanding and predicting phenomena.

Turning to the conduct of war, linearity is endemic to the theory and prosecution of the American way of war. Beginning with Henry Hallack's translation of Jomini in 1846, generations of American officers have studied the concepts of a theater of war, base of operations, key and objective points, lines of operations, and interior, exterior, concentric and eccentric lines, among a host of linear examples.[17] As a consequence, these concepts have played prominent roles in U.S. military history whether in the Allied campaigns in Europe, in DESERT STORM or even today. Current Joint doctrine, for example, reflects Jomini's influence in its definition of lines of operation: "Lines which define the directional orientation of the force in time and space in relation to the enemy. They connect the force with its base of operations and its objective."[18]

Linearity's attraction and durability in military affairs owes a great deal to its quantifiable nature and the fact that it is reasonably both precise and predictive of capability and outcome. When and where anomalies occur, scientists usually attempt to find mathematical and or technological solutions. Typically, technology is focused on gaining more accurate information about the enemy and the operational environment. This idea was recently manifest in the slogan *Lifting the Fog of War*, in which one influential strategist suggested a radical restructuring of the

U.S. military to take advantage of the potential of information technology.[19] Mathematics, on the other hand, is a tool to better predict outcomes. For example, the integration of probability equations and sensitivity formulas has, to a degree, overcome the specter of the inexplicable outcome. Leaders, then, are able to determine results of automated war-games to within an acceptable margin of error. In their respective spheres, both mathematics and technology attempt to solve the "knowledge conundrum". This is the idea that the failure of the linear approach (that war is not predictable) is attributed to the lack of some key element of information.[20] Without that information, the system acts sensitively and unpredictably to its input. For this reason, by the standards of linearity, the solution to overcoming friction in war is access to better information, thereby improving situational awareness.

With this in mind, modern operational design applies concepts like "systems" and "nodal analysis" to pursue improved situational awareness. In practice, however, the attempt often reflects merely a refinement of the linear approach.[21] Systems theory strives to understand the structure of an opponent through an analysis of its parts. COL John Warden's Five Ring Model, as an example, reflects such an approach. Acknowledging that each situation exhibits potentially different vulnerabilities, Warden ascribes five basic centers of gravity or (rings of vulnerability) that are "absolutely critical to the functioning of the state".[22] The rings include: the fielded military, the population, the infrastructure, organic essentials and leadership. In prosecuting a campaign the goal is to apply actions against the mind of the enemy command or the system as a whole.[23] Thus, action may occur directly against the enemy leadership, or take a more indirect approach, chipping away at weaker points until the path of least resistance leads to the collapse of a major vulnerability. In the best of circumstances "parallel attack" leverages the model by preventing the enemy from responding effectively to multiple, simultaneous attacks. However, much like a linear equation, his concept implies both an external and internal structural immutability and isolation. That means the operational design selected before the start of a campaign can actually capture reality. "The trick," as Michael Howard observed, "is not to get it too wrong."[24] Regardless, such an approach requires extremely detailed and accurate prior knowledge and situational awareness of the entire structure and its parts. It also requires confidence that the selected course of action is in fact correct and will remain applicable until the conclusion of the campaign. Most importantly, the Five Ring Model assumes that the enemy is incapable of significant change throughout the duration of a conflict. It is perhaps with such assurances in mind that an ancient Sufi text cautions, "You think because you understand *one* you must understand *two*, because one and one makes two. But you must also understand *and*."[25]

NONLINEARITY

In war games, as in combat, seemingly insignificant events can have a considerable impact; thus, "for want of a nail" a wholly disproportional outcome can ensue. The theory of nonlinearity reflects this reality. It disregards the qualities of proportionality and additivity, in that resulting outcomes may be erratic.[26] More to the point, disproportionally small or large outputs, relative to the inputs, flies in the face of the Western philosophical tradition, which postulates that truth resides in the simple, rather than in the complex.[27] But as Mark Twain said, "For every complex problem there is a solution that is simple, neat and wrong."[28] As a concept, nonlinearity describes the world as it is, with its inherent complexities, rather than confining its perspective to the proportionally small, but quantifiable portions of existence. By modern characterization, nonlinearity falls under the rubric of "new sciences" (including quantum physics and chaos theory).[29] All that not withstanding, Clausewitz was one of the first to capture many of the essential aspects on nonlinearity, as Alan Beyerchen observed: "Interconnectedness and context, interaction, chance, complexity, indistinct boundaries, feedback effects and so on, all leading to analytical unpredictability-it is no wonder that *On War* has confused and disappointed those looking for a theory of war modeled on the success of Newtonian mechanics."[30] Clausewitz understood that attempting to achieve exact analytical solutions was impossible given war's nonlinear reality. Therefore, the ability to accurately predict the course or result of any particular conflict was severely limited.

SENSITIVITY

Only since the advent of computers have scientists succeeded in physically demonstrating what Clausewitz attempted to capture in *On War*. By attacking nonlinear problems numerically, computers were able to also highlight patterns of instability. For example, in "chaos theory", chaos results when a system is both nonlinear and sensitive to initial conditions. In such a case immeasurably small differences in input can produce surprisingly different outcomes for the system and to a degree of complexity that exhibits characteristics of randomness.[31] However, over time systems can exhibit at least three outcomes: they can eventually settle to some single state and remain there despite further iterations (long term stability); they can settle on a series of states, through which they cycle endlessly (periodic behavior); or wander aimlessly or unpredictably (so-called "chaotic" behavior).[32] This third state is illustrated dramatically by what some scientists have termed, a "strange attractor",[33] demonstrating that perhaps there is indeed a pattern to "chaotic" behavior.

Military history possesses immeasurable examples of such behavior, ranging from institutional inertia and entrenchment to an enthusiastic commitment toward radically new thinking. In 1870, for example, despite their best intensions, the French failed to properly employ a type of early machine gun in the Franco-Prussian war. This error, combined with both a flawed command and control system and doctrine, allowed the French to rapidly fall prey to the North German Confederation.[34] And after World War I, the British Army's leadership, wishing to present their performance in the most favorable light, suppressed and distorted analytical conclusions concerning that conflict, while institutionalizing an anti-intellectual culture.[35] Conversely, in an environment of technological parity, theoretical developments, accompanied by modest resource investment and innovative doctrine, allowed the German Wehrmacht to achieve extraordinary results through *Blitzkrieg*.[36] As history suggests, the nonlinear aspect of war offers the prospect of a variety of outcomes, not necessarily apparent in the period preceding conflict. The key, however, is to recognize and positively exploit such potentialities before they become the causus belli of an opponent.

ROLE OF VARIABLES

Within a nonlinear system, it is not possible to effectively isolate variables from each other or from their context. Thus, not only do truly dynamic interactions ensue within the system, but they are a defining characteristic.[37] Unlike the cause and effect characteristics of linearity, nonlinearity embodies a more holistic universe, in which elements are viewed not only as a whole but within the context of each other. Just as the human body consists of complex groups of interdependent systems (nervous, respiratory, muscular, digestive, endocrine, skeletal, urinary, reproductive, integumentary, and circulatory), a break down of a critical organ can have a disastrous effect on the body as a whole. Thus, a human can die as easily from improper field sanitation as a projectile. From a broader military perspective, the same is true of the many essential and interrelated subsystems that contribute to combat capability: intelligence, command and control, air defense, combat power (land, air and sea) and sustainment, among others. A failure in any one of these key areas could spell disaster for the entire system. Knowing what is vital and how to seek protection, while exploiting an enemy's vulnerability is the fundamental nature of war.[38] To the degree that one can achieve destruction against an opponent with an economy of force, that is Nonlinearity.

INTERACTION

Clausewitz observed that, “War is never an isolated act.”[39] As a phenomenon, it is the interaction of antagonists played out within the realm of temporal dynamism. Consequently, understanding war requires an understanding of the nature of interaction. *On War* captures the interactive nature of war by way of three increasingly sophisticated definitions: First, the duel...an act of force to compel our enemy to do our will. In this metaphor war is not just each opponent’s sequence of intentions and actions, but the pattern generated by their mutual interaction. Moreover, Clausewitz contends that actual war never occurs without context and that its results are never absolutely final. By context he means the unique political and cultural situation that surrounds a given war. As an example, he uses the nonlinear image of combustion to exemplify how a simple quarrel can have a disproportionate effect – a real explosion (such as the wars of the French Revolution).[40] That wars are never final refers to the fact that at its conclusion (if not before), the war will have an effect. It will generate an outcome, perhaps even one that is unintended, and this will feed back into the political context. Wars, therefore, are inseparable from their context, one characterized by feedback.

Second, “war is merely the continuation of policy by other means”.[41] Here Clausewitz attempts to capture the continuously changing aspect of war, describing it as a true chameleon that exhibits a different nature in every concrete instance. In other words the ends-means relationship does not always work in a linear fashion. The constant interplay is an interactive feedback process wherein war’s character changes continually and from that process, other outcomes will flow.[42]

Finally, in his third definition Clausewitz introduces the famous model of the trinity (violence, hatred and chance manifested as people, government and army) explained through the use of a scientific metaphor: a magnetic pendulum suspended between three powerful magnets. Not readily apparent in reading *On War* is the physical result of the experiment and hence its true heuristic value. When the pendulum is released, it darts about in a seemingly random fashion, sometimes kicking out hard enough to continue swinging in a long and intricate pattern. One can never repeat the pattern, however, because man is physically unable to replicate the experiment with exact precision. In effect, Clausewitz uses this physical phenomenon to describe the modern concept of chaos theory, pointing to the difference between pure theory (with exact measurements) and the real world (filled with friction). The power of this example lies in the idea that the trinity is not made up of three *passive* points, but three *interactive* points that simultaneously pull war in different directions, forming a complex interaction each with the others.[43] It is not possible to isolate the points from either their context

or chance; hence the movements of the actions are characterized by both complexity and probability.

Moving from a scientific to a philosophical example, the idea of interaction is rooted in the ideas of two British philosophers. George Berkeley and David Hume believed that man did not passively observe and absorb knowledge; rather, by the process of observation, man creates knowledge and molds the world through his own consciousness.[44] This idea has found an echo in the contemporary words of physicist John Archibald Wheeler, whose perspective is one of a participative universe "where the act of looking for certain information evokes the information we went looking for—and simultaneously eliminates our opportunity to observe other information….[This is] a participatory process, where we create not only the present with our observations, but the past as well."[45] For example, the purpose of a command post (CP) is to acquire and transmit information. In particular, staff members within a CP are directed to look for certain elements of information: an enemy signature unit, an enemy action, status of unit and so on. Therefore, when engaged in finding out particular information they are, by omission, not looking for other indicators. In the process of acquiring and omitting information, the CP creates its own reality. To the degree that CP's reality reflects truth, it will be less susceptible to the forces of friction. This phenomenon is an embedded aspect of Nonlinearity, in that dynamic interaction is itself the catalyst for change. How interaction occurs, or is prevented from occurring as foreseen (through friction or chance), is the understanding (feedback) needed for situational awareness.

CAUSALITY AND ENERGY

Power and causality, as Hume cautions, is dependent upon knowledge, or "the relation of ideas in our minds." Clausewitz addressed the notion of causality in attempting to answer the age-old question of whether war was an art or a science. His reply was that it is neither. "In war, the will is directed to an animate object that reacts."[46] This idea springs from Hume's investigation of causality and its association with power; and his conclusion that only the mind is the true active substance. Material substance is merely passive and inert. Hume suggests that only through experience can one discover facts; in some cases investigation yields understanding. Important to this idea is the temporal nature concerning the truth of facts: what may be true today may not be true tomorrow. Science is not all a priori, Hume contends; rather, even causality exhibits randomness. This notion is found today in the expression, "The truth changes", or as Clausewitz argues, it is the very nature of human interaction itself that makes war unpredictable.[47]

Another frequently cited metaphor used to describe the unpredictable nature of causality involves the science of thermodynamics (the physics of the relationship between heat and other forms of energy).[48] In the Second Law of Thermodynamics ("the condition of a system in which the resultant of all acting forces is zero") friction is the nonlinear feedback that leads to heat dissipation of energy in a system "a form of increasing degradation toward randomness, the essence of entropy."[49] To monitor friction, scientists develop negative feedback mechanisms which signal when the system veers from its established course. This approach is useful in maintaining the status quo. If the environment changes while the system remains constant; however, the system over time may continue to function as desired, but it may also become irrelevant.

A more holistic approach takes advantage of positive or amplifying feedback. Rather than signaling a deviation in the system, amplifying feedback triggers a signal upon detecting changes in the environment. Thus, rather than adjusting the system to maintain its designated function or direction, positive feedback triggers the need to change the system in an effort to respond to changes in the environment. At a basic level these distinctions appear in the military adage of "fighting the enemy not the plan." Negative feedback signals when a plan is going astray. Positive feedback, on the other hand, identifies changes in the battlefield that may generate new dangers or new possibilities. In combat, both types of feedback are necessary precursors to effective adaptive behavior.

Taking the example of causality in combat a step further, consider that battlefield interaction takes many forms. One of the most fundamental relationships is between offensive and defensive operations. Herein, as Clausewitz demonstrated, lies a paradoxical relationship, highlighted by the concept of culmination. Specifically, the further a force prosecutes the offense, the weaker it becomes. Once the offensive force culminates, it reverts to the defensive and becomes paradoxically stronger against counterattack. In a thermodynamic sense, *active* energy is exchanged for *potential* energy. Thus, when viewed as a system, a military force in combat defies equilibrium; it is typically either gaining or losing strength. Given that the preservation of one's own force while achieving the destruction of the opponent's defines the acme of success, military force tends to respond as a "self-organizing system."[50] That means that throughout the dynamism of combat, successful military forces continually take stock of their interaction within the environment. By modifying their "ways" in order to increase their strength relative to their opponent's and by adjusting those areas requiring protection, as the situation changes, they are able to exploit opportunities and avoid culmination. Above all, the

continuous assessment of capability against that of the enemy yields an understanding of the possible within the realm of chance.

CHANCE

It is the realm of chance that offers the strongest contemporary argument for embracing nonlinearity. There are three possible manifestations of chance: "random phenomenon, the amplification of a micro-cause or a function of analytical blindness."[51] Clausewitz addressed the first two manifestations using the metaphor of a game of cards. In that game, random phenomenon results from initial inputs and the impossibility of knowing with any certainty the ultimate outcome. The fact that the game does not always react in a wholly unpredictable manner is the phenomenon that has historically strengthened the argument of those who would view war as a science rather than an art. In more recent times, equations of probability have been used to capture chance, particularly in the areas of computer modeling. Nevertheless, as one scholar has pointed out, even computer programming has difficulty replicating incompetence.[52] Perhaps a less damning, but equally salient perspective is the idea of prosecuting a bankrupt strategy – where the misapplication of overwhelming resources, as Harry Summers demonstrated, simply fails to accomplish the desired ends.[53] As to the second manifestation, by recognizing that a very slight cause can determine a considerable effect, Clausewitz captures the idea of amplification.[54] This is the very basis of nonlinearity.

Regarding the final characterization of analytical blindness, mathematician Henri Poincare warns, that "weakness forbids us from considering the entire universe."[55] As a consequence, there is a natural tendency to divide the problem and address the pieces singularly. This of course is reflective of a linear approach to war and negates the linkages which are endemic to any system. For example, even when applying new ideas for prosecuting war at the strategic level in Warden's Five Ring Model, the fourth ring (population) can be the least susceptible to direct attack, yet paradoxically is often the most important consideration.

Regardless of which manifestation chance assumes, the goal is not simply to identify it, but rather understand it. To overcome chance, then, intelligence, combined with education and training is required to comprehend what is seen. The better one side understands an adversary, the less susceptible that side will be to uncertainty. Nevertheless, no matter how much effort is applied to the collection of intelligence, it is simply impossible to know all there is about an environment, or, perhaps more importantly, accurately predict the impact of interaction within it.[56]

CHANGE

War is an open system and cannot be isolated from its environment. At the most basic level, armies recognize this fact. Commanders attempt to evaluate their capability against that of their enemy in an effort to ascertain if they are winning. Headquarters of all types are replete with status charts and environmental assessments, describing the status of friendly and enemy unit strengths and dispositions. Even as “digitization” brings to command posts the possibility of more accurate and timely information, however, the outcome is generally just the automation of a manual, linear process. This is important in so far that determining combat power is the physical result of battlefield interaction. More critical, however, are the collective responses to combat and the questions they generate. How have the antagonists changed? How has the nature of the war changed? What are the implications? These questions are not easily (or often quickly) answered and are only exacerbated by the nature of high tempo operations, in which windows of opportunity open and shut rapidly, often with little warning.

A further complexity at the strategic level is the fact that, all the elements of national power are brought to bear in a conflict. How to recognize the effect of ongoing diplomacy during combat, for example, is germane to understanding both changes in the political climate, as well as military effectiveness. If the political nature of the conflict changes, chances are the military approach must change with it. However, war is not the sole domain of the ever changing chameleon. More apparent is the “shape shifting” nature endemic to Military Operations Other Than War (MOOTWA), as operations move from peace enforcement, to peace building and peace keeping, or reversion to any previous state in the spectrum of operations. The more players involved, the more complicated the environment. What is essential, regardless of the nature of the operation, is that as leaders attempt to understand the nature of their conflict, they cannot simply divide responsibilities into discrete, “manageable pieces”. The pieces still react to each other and as they do, the nature of the environment will be shaped by them.

THE SOVIET SPONSORED PARADIGM SHIFT

Nonlinearity addresses war holistically. By imagining possible outcomes and the sensitivity of the system, it is possible to design both positive and negative feedback loops that will permit the system to deal with friction, or self organize in response to environmental change. Feedback loops account for the interaction of the component subsystems and with respect to external agents. In practice, this approach can appear radical rather than evolutionary; however, history shows that it is achievable and can be effective.[57]

Arguably the single best example of a nonlinear, holistic attempt to understand a future war fighting environment is found in the Soviet Union immediately following World War I. That country's ambitious efforts to examine the nature of war by way of a systems approach and to project the implications of its research into force design, stands as a model of applied theory.[58] What is more, the Soviet "new thinking" to that period still contributes greatly to a better understanding of the possibilities offered by embracing Nonlinearity. From the onset, the Soviets applied a nonlinear template to their analysis. At its heart was the idea of neutralizing an enemy system's capability to attain its goals. This provided the abstract, yet logical framework for their ground breaking approach toward operational maneuver.[59]

When committed to paper, the concept of operational maneuver included three major parts: fragmentation, simultaneity and momentum. First, the "fragmenting strike" was a penetrating column created from succeeding echelons. Each echelon had a specific function: break in, break through, break out and advance to the operational depth.[60] The aim of deep penetration was to achieve a deep center of gravity, which provided a position of advantage when reverting to the defense. Once again Clausewitz' thoughts on the nature of culmination ring true,

> Far from being idle sophistry, we consider it to be the greatest disadvantage of the attack that one is eventually left in the most awkward defensive position.…This is why the great majority of generals will prefer to stop well short of their objective rather than risk approaching it too closely, and why those with high courage and an enterprising spirit will often overshoot it and so fail to attain their purpose. Only the man who can achieve great results with limited means has really hit the mark.[61]

The "fragmenting strike" could serve two purposes. In the form of a "dividing strike" it severed an operational entity from its broader strategic complex; this included isolation from the environmental context, or the isolation of a subsystem from the super-system. As a "sundering strike" the goal was to separate the operational system into discrete compact tactical segments, then isolate, encircle and destroy them.[62]

The second aspect of operational maneuver involved "simultaneity", which Soviet theoreticians believed could yield synergy. The holding actions of a frontal echelon, combined with an air-mechanized desant echelon (operating at the extreme end of the operational depth) and a mobile maneuvering echelon, achieved the effect.[63] By operating in the areas behind the enemy's front lines and achieving success in depth, the Soviets expected to achieve enemy paralysis. Imbedded in the idea of achieving synergy were three design features: tactical

synthesis (the creation of combined arms units to overcome battlefield complexity), synchronization (achieved through a common consciousness shared by commanders of all echelons) and finally, coordination (communications, briefings and counsels focused on achieving the linear aspects of interaction).[64] The importance of this architecture is that the Soviets designed a concept that addressed both the linear and non-linear aspects of war. By forming combined arms teams, the Soviets also created a "fractal structure" that was adaptive to the changing nature of combat. The idea of a shared consciousness responded to the cybernetic aspects of interaction by way of feedback. Lastly, coordination design acknowledged that linear processes were still very much within the nature of war and required attention, albeit within the greater environmental context.

The third aspect of operational maneuver was momentum. It was based on velocity, articulated in terms of depth, time and mass, and related to striking power, which was produced by attacking the system at every point in time in the course of the operation.[65] Much like synergy, momentum comprised four design elements captured by the expression "tempo of the operational advance": depth (provided the special setting for the operation), resistance (represented attrition and affected momentum directly through slowing of velocity or reducing mass), mass (achieved through the echeloned structure that ensured the succession of strike and increased the pace of operations), and operational mobility (the key to preserving striking mass, defined by tactical velocity, logistical support and successive operations).[66] From a nonlinearity perspective, momentum helped to overcome the sensitivity of the enemy system. By adopting an offensive approach that achieved paralysis quickly and in depth, momentum prevented the enemy system from mutating. Simply put, the opposing system was denied time to respond to the attacker's interaction. To the extent that one side could affect multiple subsystems simultaneously and in depth, that side could also achieve paralysis all the faster. Once again, however, the Soviets did not turn their backs on linearity. "Resistance" acknowledged the interaction of the offense and defense, as well as their potentially linear paradox: culmination. Similarly, the recognition of logistical support and successive operations suggested the need for sequential operations.

Allied to all of this was an innovative approach to command and control as an integral part of operational maneuver. The Soviets addressed command and control by recognizing that attrition and randomness were the principle factors that determined the character of the tactical level.[67] Thus, they believed, friction could be overcome through execution of battle drill: simple, immediate and effective responses, implemented by the tactical decision maker. Command and control at higher levels included an approach comprising the designation of the operational aim,

immediate mission and subsequent mission. This was an attempt to galvanize the striking echelon's unity of effort and in some respects served as a "mission type order." Nevertheless, despite this admittedly scientific approach, the principal quality required from a Soviet operational director was still creativity; and the setting of command and control systems at the Army and Front levels called for planned improvisation.[68] So it was that the Soviets clearly articulated both the type of decision making required at each major echelon and the necessity to transmit and translate instructions between echelons.

Finally, the Soviet's did not limit their overall approach merely to paralysis. The strike echelon was expected to "encircle" and destroy components of the enemy defense.[69] As an example, the isolation and destruction of the enemy's Air Defense system augmented dislocation and facilitated airborne operations, thus exploiting the connectivity between subsystems. The nonlinear implications of this idea suggest that while non-lethal or precision strikes may achieve an asymmetrical result, those same efforts may also require destruction to yield the complete psychological, morale breaking, if not incapacitating effect at the highest levels.

NONLINEAR IMPLICATIONS FOR JOINT DOCTRINE

The American approach to jointness can be traced at least as far back as Winfield Scott's sea and land operations in the Mexican War.[70] However, *cooperation* not *command* was the order of the day. Even the U.S. Army Air Corps in World War II may be accused of, at best, *coordinating* their efforts with ground maneuver.[71] Taken to the extreme, U.S. Air Force operations in Vietnam were conducted not under the control of a Joint Force Air Component Command (JFACC) but rather divided by a convoluted Route Package system which separated control between Commander in Chief U.S. Pacific Command (CINCPAC) and Military Assistance Command, Vietnam (MACV).[72] All of this should not be surprising. From a purely spatial dimension perspective, the laws of physics and limitations of weapon systems historically prevented services from interfacing except on the margins. Only in recent years, notably during Operation DESERT STORM, has the convergence of technologies yielded a meshing of service areas of operations into a truly Joint Theater of Operations. Like it or not, U.S. military history is one of compartmentalized excellence, marked today by the world's premier Army, Navy, Air Force and Marine Corps. However, outright merger is not an answer. Unlike the Ford Motor Company, which from 1958 to 1960 attempted to combine the best design qualities of several popular cars into a distinctively new model, the United States Department of Defense cannot afford to create a "Joint Edsel."

Joint warfare, under current doctrine, is described as “team warfare”.[73] Like most metaphors, the term “team” can be misleading. In war, unlike sports, only the victor can enforce the rules and a true genius makes his own. Likewise, in today’s vernacular the word “team” can represent a collection of specialists working together. While this may translate easily into a vision of a multi-service organization working with a unity of effort under the direction of a visionary coach, it is in the end a linear approach to warfare, one that may not be up to the demands of the future. From a physical standpoint the word Joint is described as “the configuration by which two or more things are joined”.[74] But is a collection of disparate organizations bound together to achieve a common purpose the type of force needed for the future? Perhaps more importantly, is U.S. Joint doctrine sufficiently strong, yet elastic enough to ensure both unified and flexible operational employment?

The answer to both questions will remain negative as long as current Joint doctrine reflects a pedestrian understanding of Nonlinearity. By limiting the comparison of linearity and nonlinearity to the confines of geography, Joint doctrine fails to capture a holistic approach to warfare, one of dynamic interaction between systems and subsystems. Instead, Joint Publication 3-0 describes nonlinear operations as an objective oriented approach, prosecuted simultaneously along multiple lines of operations from selected basis.[75] Jomini’s influence lives on!

THEORY AND STRATEGY – THE CLAUSEWITZIAN LITMUS

Few strategists seem to view the theory of war in the same way; perhaps it is due to the nature of the subject. From a broad U.S. perspective, thoughts about war are largely borrowed, sometimes plagiarized, mostly from European sources. U.S. doctrinal publications are sprinkled with theoretical sound bites of past masters; some ideas are transient, others abide. Clausewitz appears to have the greatest impact on current doctrine, perhaps because he wrote in the general rather than the specific, or because his work continues to be freshly interpreted. What is comfortable about Clausewitz is that his ideas appear to fit Americans like a glove. The supremacy of political authority over the military, the will of the people, and quick, decisive battle reflect not only U.S. society, but how the American people like to fight. Yet, as has been demonstrated, Clausewitz also clearly marked the role of nonlinearity in the doctrinal approach to warfare. In this regard there are three fundamental lessons to be learned from the Prussian philosopher and nonlinearity: first: theory should avoid prescriptive doctrine - leaders must develop intuition; second: every military act will have political consequences - variables cannot

be isolated; and lastly, adherence to unchanging principles is dangerous - what matters is adaptability.[76]

Taken as a whole, there has been a mixed American reaction to Clausewitz's nonlinear doctrinal lessons. Few would accuse the U.S. of being dogmatic in the application of Joint doctrine, perhaps because that doctrine is the result of interservice compromise and therefore by its very nature non-prescriptive. Conversely, to the degree that U.S. forces continue to train under realistic conditions, intuition is being developed by combat leaders. But this is primarily at the tactical level. As to the political consequences of military operations, Joint doctrine does articulate the process of developing strategy and recognizes that wars are fought for political goals. But it falls short of recognizing the political consequences of military operations.[77] And with respect to unchanging principles, the one thread of continuity that does run through Joint and Service doctrine is the "Principles of War". Although a recent addition to some services' lexicon, they serve as "the enduring bedrock of US military doctrine," the principles that "guide warfighting at the strategic, operational, and tactical levels."[78] This is assuredly more than Clausewitz had in mind since he viewed principles to be useful in the study, not prosecution of war. As for their applicability from tactical to strategic levels, the current doctrine falls far short of applying Clausewitz's lessons of nonlinearity. Joint Publication 3-0, for example states that "[t]he purpose of maneuver is to place the enemy in a position of disadvantage through the flexible application of combat power."[79] Such a positional, kinetic energy approach may well apply at the tactical level; but it does not do justice to the nonlinear aspects of seeking influence at the strategic level.

Incorporating the lessons of nonlinearity into the current Joint doctrine will not be an easy task. The strategist Colin Gray argues that war is by its very nature complex and therefore offers complex solutions. In his book, *Modern Strategy*, Gray suggests that there are (at least) seventeen dimensions of strategy. More importantly he argues that these are merely "distinctive dimensions of a whole entity…each influences the other."[80] He then groups the seventeen under three headings: people and politics, preparation for war and war proper, a holistic approach that in many ways shares portions of Warden's Five Ring assessment. But Gray's approach goes well beyond the linearity of Warden's concept; emphasizing instead that war is a human activity and can therefore be input sensitive. Strategy is eternal because it reflects human nature; likewise, the lessons of historical experience are shaped as much by perception of the past as the facts themselves. This is a significant argument because the consideration of human interaction quickly moves the dimensions of strategy beyond the physicality of linear warfare, to the sensory, intuitive, cognitive, cultural and the metaphysical that plays such an

important role in the nonlinear approach. Suddenly the nature of conflict appears far more abstract, than the predominately physical, linear character of Warden's model.

SENSITIVITY, VARIABLES AND INTERACTION

Since Nonlinearity is the recognition of the holistic nature of war, a corresponding American approach to Joint doctrine should focus on interaction, rather than simply cause and effect. Future war may be distributed, nodal and geographically isolated. It may just as well be asymmetrical, socially imbedded and motivated by abstract religious or political doctrine. It is just not possible from a nonlinear perspective to separate these variables from each other or from their context. Above all, it must be remembered that Nonlinearity captures a system's (or strategy's) outcome in response to inputs and even small differences in these inputs can produce entirely different outcomes, some even approaching randomness, for the system. For example, if the United States adopts a strategy of forward presence punctuated by power projection, it might do well to remember that it is, in the end, an offensive doctrine prosecuted in someone else's back yard.

A possible counter to this approach, as an example, is found in the American Revolution where the British fought in the southern colonies against a partisan force led by Nathaniel Greene. This conflict, as Weigley demonstrates, was first and foremost a mismatch of objectives. On the British side was the *limited* objective of achieving stability in North America. From the colonial perspective, completely eliminating British power in the colonies was their *unlimited* objective.[81] The British, seeking sympathetic colonists, moved their operations to the south and applied a system of outposts whereby key "nodes" were defended.[82] Meanwhile, patrols secured the countryside, often in a heavy handed manner. Equipped with an unmatched fleet, British forces were able to deploy flexibly in response to threats. Moreover, they could chose the time and place of their assault and lines of operation. When regular Continental forces deployed to assist Greene, the British defeated them handily. However, what the British could not do was create a safe and secure environment for sympathetic colonists or, for that matter, themselves.[83] Over time, British forces were simply exhausted from pursuing a partisan force that avoided battle, unless to the Patriot's advantage. In the end, the British were forced to withdraw from the southern colonies entirely.

The power of this vignette is that, although the British believed they had freedom of action, secure bases, the capability to mount simultaneous operations and both better command and control and sustainment, they failed to accurately assess the nature of their interaction. British reprisals inflamed the populace and eroded support for the crown, achieving just the opposite

effect from the example of security the British had hoped for. Their chosen "system" was sensitive to the act of reprisals, and generated an unexpected outcome. Moreover, as the nature of the war changed, the British failed to adapt to the new environment. The British, while appearing nonlinear, were in point of fact, just the opposite. Nonlinearity therefore is more than simply a spatial or temporal approach to war; it is holistic in the purest sense of the word. It captures the idea of *cognition,* in many ways, as Clausewitz described *understanding* the nature of the war.

Turning to strategy as a system, the British naval strategist Julian Corbett defined it as "the art of directing force to the ends in view." He also defined the ends by their object: "Major Strategy, dealing with ulterior objects: Minor Strategy, with primary objects."[84] While admittedly current U.S. doctrine captures these ideas as "strategy" and "operational art", the significance of this approach lies in the recognition that Major Strategy deals with the "whole resources of the nation for war. It is a branch of statesmanship. It regards the Army and Navy as parts of one force, to be handled together; they are instruments of war."[85] Corbett's perspective was that achieving a common understanding of a theory of war drives one to become a single force. In other words education leads one to common conclusion, and obviates the need for such externally driven mandates as the Goldwater-Nichols Act. This is not to suggest that America's future envisions a single military service as in Canada, but it is also more than simply the lashing together of a guild of services and proclaiming unity. Such action would serve no more purpose than covering the services in a doctrinal fig leaf. Underneath they would remain theoretically naked and alone, arguably as they have always been. The implication of embracing a holistic theory is that a top down understanding of interaction of inter and intra service relationships will ultimately yield a broader, more flexible approach to warfare, one that includes a unity of effort among all elements of national power. The Joint approach must apply a "common grammar", yet remain creative in its dialogue. For the United States, the time has come to develop a theory of war for a new age and with it, a common "Joint" grammar.

FEEDBACK, CHANGE AND CAUSALITY

Attempting to design a Joint doctrine that incorporates the ideas associated with Nonlinearity involves as complete an understanding of the nature of war as is humanly possible. As Gray asserts, it is a complex business. Nevertheless, identifying all the possible dimensions (though situationally dependent) is the first step toward addressing *how* the dimensions interact. Next, having identified the dimensions, the construction and position of positive and negative feedback loops will provide continual information at all levels of war throughout the continuum of

the conflict. This nonlinear approach is essential because of the need to continually "sample" information to determine the nature of interaction between each strategic dimension and across the system as a whole. This is especially important in attempting to overcome friction, since the ability to recognize the nature and possible impact of that phenomenon, and modify operations and future plans accordingly, is essential to both relevance and success.

Feedback, as a process, means identifying intelligence requirements that are more than simply linked to decision points. They must be dimensionally evaluative. As the nature of the conflict changes, the goal must be to recognize change and then foresee its possible permutations across all relevant strategic dimensions. This may take time and run counter to the presumed nature of Rapid Decisive Operations. Given the variety of dimensions, their often nonmilitary nature and the complexity of dimensional interaction, the sources of information must be broad. Lateral dialogue between services, mediums, agencies and Allies, will be essential to situational awareness and environmental understanding. There is, of course, the potential for friction in such a complex methodology; but friction, as Clausewitz long ago pointed out, is a fact of life in any approach to war. More importantly, the relatively small frictional advantage provided by nonlinear feedback can have enormous outcomes in combat. But any advantage relies, in particular, on the constraints imposed by human physical and cognitive limits, particularly those dealing with informational uncertainties and unpredictable differences resulting from spatially and temporally dispersed information and most importantly, from the innate structural nonlinearity of the combat process.[86]

From a structural perspective, then, a nonlinear approach to war will yield more than simply the superficial integration of services. Developing a common theory of war, from which service strategies evolve, is the first step of what will arguably be a long term process. Current Joint doctrine is one of compromise and committee work: a collection of principles, fundamentals, tenants, values and considerations that obfuscate the purpose of achieving shared belief. Joint doctrine requires a common, not parallel, exploration of future war, in which a "single force" seeks the capability to attack the physical, mental and moral aspects of an opponent, in pursuit of clearly articulated policy objectives. Although each service contains the resident expertise to operate and dominate a particular dimension, technology (if not theory) is driving the services increasingly to share battle space. The future debate of roles and missions is long over- due, but will be futile without a common understanding of war, the essence of Joint doctrine.

Human beings will always reach a limit of cognitive capability. To the extent that a new generation of leaders is more attune to the dynamic, interactive nonlinear nature of war, the

more likely it will be both mentally creative and adaptable. Nevertheless, limits in individual ability, experience and training will always induce friction in the force. That the military may have to cooperate with other agencies or Allies in the future will only further limit the shared corporate consciousness. Distributed spatial and temporal operations will only further exacerbate the friction induced by differences in comprehension and capability. That is the nature of this world. To the extent that U.S. forces can recognize these challenges, develop an awareness of potential sources of friction and monitor the interaction of systems within the environment, the Joint force will ultimately become a much more adaptive, effective and durable organization.

CONCLUSION

Centuries of linear thought continue to heavily influence U.S. military doctrine, education and culture. Nonlinearity offers the American armed forces the opportunity to reconsider how to fight, how to organize, and most importantly how to think about the challenges of future war. The Soviets, faced with perceived threats and a changing world nearly a century ago, embarked on a course which propelled them to the forefront of innovative theory, manifest as doctrine, structure, education and procurement. Their journey was replete with controversy, clashes of professional ego and intense political dialogue. Ultimately, Stalin suppressed these ideas through purge, only to resurrect them again in the face *Blitzkrieg*. Today, developing a holistic theory that captures the contemporary environment, with all its inherent complexities will not be easy, but it is just as possible. Embracing new thinking offered by nonlinearity while continuing to incorporate the “tried and true” will potentially change the entire U.S. military culture, from training and education, doctrine and equipment, to interagency and multi-national cooperation. But as Colin Gray warns, “Change in form is ever confused with change in kind. Possible revolutions in the character *of* warfare are mistaken for revolutions in the nature of, or even *from*, warfare.”

The concept of nonlinearity involves more than geometry; it is recognition of the dynamic, interactive nature of warfare and the complex connectivity of the human dimension. It is not simple. Neither is war. But what nonlinearity provides is a construct for understanding the changing character of war and allowing for the recognition of friction before reaching culmination. The result is intuition to recognize the implications of the changing situation and *adaptability* to allow for appropriate action. Achieving success in both these abstract capabilities is found in the nature of education, training, procedure and finally structure. In that regard nonlinearity offers a way to leverage the best of service cultures and capabilities, while providing the opportunity to discard centuries of unwanted baggage. In the end, however, the U.S.

military's ability to understand the environment, its interaction within it and the changing nature of conflict until conclusion, will ultimately determine its success.

As America comes to grips with its new found role of global "hyper-power," the international stage will change with new, yet unwritten dramas unfolding. New players will join the improvisation, bringing with them challenge and intrigue, interests and alliances. And above it all, Tyche observes, like an interactive audience whose fickle attention changes with the season and fashion. Balancing her capricious moods and unpredictable nature will require a presence of mind that is attuned to the nature of the environment, the actors and the audience. But that is what distinguishes the great from the popular, and in the end determines who remains at center stage, taking the final bow.

WORD COUNT = 8,929

ENDNOTES

[1] John DeFoor, ed. "Intro," *Joint Operational Warfighting (JOW*) (Norfolk: U.S. Joint Forces Command, 15 August 2002), 1.

[2] Ibid., 4.

[3] In the original Greek version of *The Peloponnesian War*, Thucydides refers to "Tyche" to explain that which by the ordinary course of events could not be predicted. Tyche was the Greco-Roman personification of fortune, chance and luck. With a ball she represented the various unsteadiness of fortune – unsteady and capable of rolling in any direction. Williamson Murray, "Presentation to Advanced Strategic Arts Program," lecture, Carlisle Barracks, PA, U.S. Army War College, 6 January 2003, cited with permission of Mr. Murray.

Thus, Thucydides introduces the idea of nonlinearity in his history by way of mythological metaphor. See Michael Jordan, *Encyclopedia of Gods* (New York: Facts on File, Inc., 1993), 269.

[4] "Clausewitz displays an intuition concerning war that we can better comprehend with terms and concepts newly available to us: *On War* is suffused with the understanding that every war is inherently a nonlinear phenomenon, the conduct of which changes its character in ways that cannot be analytically predicted." Alan Beyerchen, "Clausewitz, Nonlinearity, and the Unpredictability of War," *International Security*, 17 (Winter 1992): 60.

[5] "Plato's theory of ideas conceived of an ideal world of forms, separate from the earthly sphere, in which the paradigms of worldly objects resided." Chris Rohmann, *A World of Ideas* (New York: Ballantine Books, 1993), 295.

"According to the paradigm model, Forms are just paradigmatic instances. Thus, for example, Equality is simply the perfect instance of equality. Equality is somehow perfectly equal, and all other things that are equal are approximations of Equality, perhaps in the same way that only the standard meter stick in Paris is exactly a meter long, while all other meter sticks approximate its length. Something is a meter long just insofar as its length sufficiently resembles the length of the standard meter stick in Paris. Similarly, something is beautiful just insofar as it sufficiently resembles the Form of Beauty." Dion Scott-Kakures, *History of Philosophy* (New York: Harper Collins Publishers, Inc, 1993), 36.

[6] Rohmann, p. 296. Also see Thomas Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 1962).

[7] Dava Sorbel, *Galileo's Daughter: A Historical Memoir of Science, Faith and Love*, (New York: Walker and Co, 1999), 221: The complete title was *"Dialogue of Galileo Galilie, Lyncean Special Mathematician of the University of Pisa And Philosopher and Chief Mathematician of the Most Serene Grand* Duke *of Tuscany. Where, in the meetings of four days, there is discussion concerning the two Chief Systems of the World, Ptolemaic and Copernican, Propounding inconclusively the philosophical and physical reasons as much for one side as for the other*."

[8] Ibid., 50-53.

[9] Rohmann, 296.

[10] Ibid.

[11] For a more detailed study see, David Jablonsky, *Paradigm Lost? Transitions and the Search for a New World Order* (Carlisle Barracks, PA: Strategic Studies Institute, 1993).

[12] "Military innovations that have the greatest influence are those that change the context within which war takes place." Williamson Murray, "Innovation: Past and Future," *Military Innovation in the Interwar Period* (New York: Cambridge University Press, 1996), 305.

[13] "His master Prince August was given command of a battalion, and Clausewitz accompanied him to the battlefield of Auerstadt. There he participated in his first great Napoleonic battle and in the catastrophic retreat that followed; an experience so shatteringly different from the tedious marches and manoevers of his boyhood that it was hard for him to comprehend them both as belonging to the single activity, war." Michael Howard, *Clausewitz* (New York: Oxford University Press, 1983), 8.

[14] "If the direct question is put whether there was any influence of the theories of Clausewitz and Schlieffen on the German conduct of two world wars, the answer is in the affirmative. There is no doubt that Schlieffen's attitude of conducting war as a purely military affair provided a decisive contribution to failure. Closely linked with this blunder was Schlieffen's obsession with the enemy's annihilation by means of encirclement as the only possible strategic solution. On the other hand the fact that the Germans had not understood Clausewitz' philosophy, and therefore had never heeded his theory or the practical implications to be derived from it, was without a doubt a vital factor in Germany's defeat." Jehuda L. Wallach, *The Dogma of the Battle of Annihilation* (Westport: Greenwood Press, 1986), 312.

[15] Murray, 314-315.

[16] Beyerchen, 61.

[17] Henry W. Hallack, *Elements of Military Art and Science or, Course of Instruction in Strategy,* Fortification*, Tactics of Battles, etc; Embracing the Duties of Staff, Infantry, Cavalry, Artillery, and Engineers* (West Port: Greenwood Press, 1971). As a Captain in 1846, Hallack translated and edited Henri Jomini's *Vie politique et militaire de Napoleon*, under the title cited above. This document was influential in the professional education of Army officers prior to and during the American Civil War.

[18] U.S. Joint Staff, *Doctrine for Joint Operations,* Joint Publication 3-0 (Washington: Government Printing Office, 2001), GL-12.

[19] Bill Owens, Lifting *the Fog of War* (New York: Farrar, Straus and Giroux, 2000), 13-15 and 22-24.

[20] Consider the U.S. military's attempt to capture and transfer knowledge. "In the traditional knowledge-acquisition approach, knowledge engineering involves transferring and transforming an SME's knowledge into a form usable by an intelligent agent. A skilled knowledge engineer ordinarily performs this highly technical process, which is time consuming, error prone, and

inefficient. An alternative approach is to use a computer-based learning agent, which can acquire and maintain the SME's knowledge with only limited assistance from a knowledge engineer." Antonio M. Lopez et al, "Clausewitz Meets Learning Agent Technology," *Military Review* Vol. LXXXII, no. 6 (November-December, 2002): 2.

[21] Ron Zemke, "Systems Thinking," *Training: The Human Side of Business* Vol. 38, no. 2 (February, 2001): 40-41. Zemke argues that the "systems approach" is in transition from one that is mechanistic to counterintuitive, which requires new thinking.

[22] John A. Warden III, "The Enemy as a System," *Airpower Journal*, Vol. 9, no. 1 (Spring, 1995): 40-55.

[23] Ibid., 49.

[24] Michael Howard and C.R. English, *Report of the Committee of Inquiry Into Service Colleges*, 29 July 966; quoted in Michael Brock, "Michael Howard's Contributions to Historical Studies," *War, Strategy, and International Politics. Essays in Honour of Sir Michael Howard*, eds., Lawrence Freedman, Paul Hayes, Robert O'Neill (Oxford: Clarendon Press, 1992), 198.

[25] Donella Meadows, "Whole Earth Models and Systems," *Co-Evolution Quarterly* (Summer, 1982): 98-108; quoted in Margaret J. Wheatley, *Leadership and the New Science* (San Francisco: Barrett-Koehler Publishers, 1999), 10.

[26] Beyerchen, 62.

[27] "Anaxamines appears to have thought that we ought not postulate the existence of anything that is not required to explain the world and its phenomena, especially when the postulate is unobservable. With this we get what looks like an explicit appeal to two principles that will recur in one form or another throughout the history of Western philosophy: the principle of the priority of observation and the principle of ontological simplicity." Scott-Kakures, 3.

[28] Zemke, 40.

[29] Wheatley, 3-4.

[30] Beyerchen, 77.

[31] Ibid., 64.

[32] Barry D. Watts, *Clausewitzian Friction and Future War* (Washington: National Defense University, 1996), 106.

[33] "If the system is plotted in multiple dimensions in phase space, the shape of chaos, the strange attractor, gradually becomes visible…As the system's chaotic wanderings are plotted over time (the system never repeats its behavior exactly), the attractor reveals itself. This butterfly or owl-shape strange attractor reveals the order inherent in a chaotic system." Wheatley, 116-117.

[34] The mitrailleuse was “an early machine gun mounted on an artillery carriage, and similar to the Gatlin gun of the American Civil War. The mitrailleuse was expected to give the French a great technological advantage over the Germans, but was kept so secret that few French commanders had any idea how to get the most out of it; in the Franco-Prussian War, the weapon was kept back with the artillery and usually out of range of the enemy.” Larry D. Addington, *The Patterns of War Since the Eighteenth Century* (Bloomington: Indiana University Press, 1984), 98.

[35] “[Field Marshal Archibald Montgomery-]Massingberd was an out-and-out opponent of serious innovation; his successor Field Marshal Cyrill Deverell was little better.” Murray, 20-22.

[36] Ibid., 34-45.

[37] Beyerchen, 64.

[38] ‘The object of war is specifically “to preserve one self and destroy the enemy” (to destroy the enemy means to disarm him or “deprive him of the power to resist”, and does not mean to destroy every member of his forces physically).’ Mao Tse-tung, *Selected Writings of Mao Tse-tung* (Peking: Foreign Language Press, 1967), 230.

[39] Carl Von Clausewitz, Michael Howard and Peter Paret, ed., *On War* (Princeton: Princeton University Press, 1976), 78.

[40] Clausewitz, 75 and Beyerchen, 65-66.

[41].Clausewitz, 87.

[42] “The war is a contest between these characteristics. They will change in the course of the war, each according to its own nature; and from this everything else will follow. These characteristics exist objectively and are not invented to deceive people; they constitute all the basic elements of war, and are not incomplete fragments; they permeate all major and minor problems on both sides and all stages of the war, and they are not matters of no consequence.” Mao, 198.

[43] Clausewitz, 89 and Beyerchen, 67-68.

[44] Regarding Hume, “Our ideas about the world are purely the result of the mind’s association and ordering of impressions according to “custom” or “natural beliefs”-our habitual ways of thinking.” Rohmann, 186-187.

[45] Wheatley, 64-65.

[46] Clausewitz, 148-149. See also Scott-Kakures, 213-215.

[47] “Hume is saying that because we are so used to seeing objects behave in certain kinds of ways, we think we could have known how they would behave without ever having witnessed their behavior. But that is simply not the case. When presented with new objects or circumstances, we do not really know what to expect.” Scott-Kakures, 215. See also Clausewitz, 139.

[48] William Morris, ed. *The* American *Heritage Dictionary of the English Language* (Boston: Houghton Mifflin Company, 1976), 1336.

[49] Beyerchen, 72.

[50] Wheatley, 80.

[51] Beyerchen, 73.

[52] The ideas in this paragraph are based on remarks made by a speaker participating in the Commandant's lecture Series. For the metaphor of a game of cards, see Clausewitz, 86.

[53] Harry G. Summers, *On Strategy* (New York: Ballantine Books, Inc., 1995), 184-185.

[54] "Whenever a self-organizing system experiences any amplification process, change is at hand. If the amplifications increase to the level where they destabilize the system, the system can no longer remain as it is. At this moment, the system is at a crossroads, standing poised between death and transformation." Wheatley, 87-88.

[55] Beyerchen, 75-76.

[56] "Expressed in the language of nonlinear dynamics, Laplace's presumption is that human ignorance prevents us from completely eliminating tiny differences between our representations of phenomena and their actuality." Watts, 115.

[57] Naveh goes so far as to decree that the Coalition victory in Desert Storm was, in practice, the fruition of Soviet concepts. Namely that Allied forces held the Iraqis in position, while a strike echelon penetrated the defenses deeply. The operation was augmented by heliborn operations and air support and supported by a deception plan (Marines off shores). The synergistic effect of Coalition operations fragmented the Iraqi defenses and totally disrupted their ability to maintain a cohesive strategy. Shimon Naveh, *In Pursuit of Military Excellence: The Evolution of Operational Theory* (London: Frank Cass, 1997), 323-331.

[58] "This threat [perceived proletarian and bourgeois struggle] created a need to study future war [budushchaia voina], not as an abstract proposition but as a foreseeable contingency. In the 1920s the study of past campaigns, current trends in weapons development, and force structure requirements coalesced around the concept of operational art [operativnoe iskusstvo]." Jacob W. Kipp, *Mass, Mobility, and the Red Army's Road to Operational Art, 1918-1936* (Fort Leavenworth, KS: Soviet Army Studies Office, 1988), 16.

[59] Naveh, 323-331.

[60] Ibid., 214.

[61] Clausewitz, 572-573.

[62] Naveh, 214-215. Also see G. Isserson, "Operational Prospects for the Future", *Volume I, Operational Art, 1927-1964, The Evolution of* Soviet *Operational Art 1927-1991: The Documentary Basis,* trans. Harold S. Orenstein (London: Frank Cass, 1995), 83: "Therefore, *the*

penetrative force of a deep attack acquires decisive significance for the development of modern operations. The potential for maneuver development of operations depends now not so much on rapidity of the attack, but on the force of the attack."

[63] Naveh, 216. Also see Vasiliy Yefisovich Savkin, *The Basic Principles of Operational Art and Tactics (A Soviet View),* trans. and published under the auspices of the United States Air Force. (Moscow, 1972), 216: "A deep deployment of shock groupings in the presence of major mobile *soyedineniya* in the second echelon of fronts (tank armies) was supported by strong aviation. Thus the shock groupings possessed great penetrating force and an ability to affect the enemy to a great depth and to build up forces in the course of an operation. This provided for high rates of advance."

[64] Naveh, 223.

[65] Ibid., 217.

[66] Naveh, 217-218. Also see Isserson, 84: "Therefore, above all, *the struggle to exploit all capabilities* lies at the basis of conducting modern military operations. And this means *speed*. Thus, speed will become a property organically inherent in the nature of modern operations."

[67] Naveh, 232. Also see Savkin, 275: "Increasing importance was assumed by control on the part of commanders-in-chief (commanders) or staff officers. A plan of control began to be compiled. Under it were checked: timeliness of obtaining missions and correctness of troop understanding of missions obtained; course of preparation of the operation and combat operations; readiness of troops for an attack; organization of interworking; knowledge of the enemy; material support to troops and other questions. One of the basic methods of control were flights of aircraft with the aim of checking the true status of friendly troops on the battlefield and the organization of concealment in the initial position"

[68] Naveh, 235-236.

[69] Naveh, 215. Also see Kipp, 24: "The Vremennyi polevoi ustav RKKA 1936 with its emphasis upon the "decisive offensive on the main axis, completed by relentless pursuit" as the only means to bring about total destruction of the enemy's men and equipment underscored Tukhachevsky's twin themes of combined arms and mechanized forces."

[70] For more information concerning Winfield Scott and the origin of U.S. land sea cooperation in the Mexican campaign, see John S. D. Eisenhower, *Agent of Destiny: the Life and Times of General Winfield Scott* (Norman: University of Oklahoma Press, 1997).

[71] The ideas in this paragraph are based on remarks made by a speaker participating in the Commandant's Lecture Series.

[72] "This fragmented approach stood in stark contrast to the most basic beliefs about the employment of air power going back to World War II and before." Benjamin S. Lambeth, *The Transformation of American Airpower* (Ithaca: Cornell University Press, 2000), 32-34.

[73] U.S. Joint Staff, *Joint Warfare of the Armed Forces of the United States,* Joint Publication 1 (Washington: Government Printing Office, 2000), viii.

[74] Morris, 706.

[75] Joint Pub. 3-0, IV-9.

[76] Beyerchen, 81-82.

[77] Joint Pub. 3-0, III-24.

[78] Joint Pub. 1, III-7 and Joint Pub. 3-0, A-1. Also see Wallace P. Franz and Harry G. Summers, *Principles of War: The American Genesis,* (Carlisle Barracks, PA: An Occasional Paper from the Strategic Studies Institute, 1981), iii: "In 1934 when [Colonel Johnston's article] was published, the principles of war had dropped from sight and Colonel Johnston was making the case for principles of war per se as well as recommending a particular set of principles. Drawing from his own experiences as well as from the works of Colonel Fuller, particularly his 1925 work, The Foundations of the Science of War, Colonel Johnston reduced the "science of war" to what he believed to be its essence: Objective, Means and Control."

[79] Joint Pub. 3-0, A-1.

[80] Colin S. Gray, *Modern Strategy* (New York: Oxford University Press, 1999), 24-43. Grey identifies many dimensions of strategy and organizes them into three groupings: *People and Politics* – people, society, culture, politics, ethics; *Preparation for War* – economics and logistics, organization, military administration, information and intelligence, strategic theory and doctrine, technology; and *War Proper* – military operations, command, geography, friction, chance and uncertainty, adversary, time.

[81] Russell F. Weigley, *The American Way of War* (Bloomington: Indiana University Press, 1973), 18-19.

[82] Ibid., 26.

[83] "Without forcing Greene to battle, he could not prevent the Revolutionaries from resuming their reconquest of the South everywhere except where the British field army stood." Weigley, 34-35.

[84] Julian S. Corbett, *Some Principles of Maritime Strategy* (Annapolis: Naval Institute Press, 1988), 308.

[85] Ibid., 308.

[86] Watts, 132.

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